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GAS TURBINE VENTILATION CIRCUITRY

The invention relates to the field of ventilating a high pressure turbine in an aircraft turbomachine.

More precisely, the invention relates to a turbomachine having a sealing device between the turbine rotor and the inner casing of the combustion chamber, said turbine rotor comprising firstly, a turbine disk presenting an upstream clamping annulus for fastening it to the downstream cone of a compressor and, secondly, a flange that is disposed upstream from said disk and spaced apart from the disk by a cavity, said flange having an inside bore that is traversed by the upstream clamping annulus of said disk and an upstream clamping annulus so it can be fastened onto said downstream cone, a first air circuit secured to said inner casing in order to deliver a first flow of cooling air into said cavity via main injectors and holes made in said flange, said sealing device comprising a discharge labyrinth between the downstream cone and said inner casing, a main under-injector labyrinth disposed between the flange and the inside wall of the first air circuit, and at least one over-injector labyrinth disposed between the flange and an annular structure provided between the outside wall of the first air circuit and said inner casing, a second flow of cooling air flowing inside a second circuit that is defined by the enclosures that are delimited by said inner casing and said rotor, via said labyrinths, and being evacuated in part in the venting cavity of said disk.

Figure 1 shows one such high pressure turbine rotor 1, disposed downstream from a combustion chamber 2, and comprising a turbine disk 3 fitted with blades 4, and a flange 5 disposed upstream from the disk 3. The disk 3 and the flange 5 both include respective upstream clamping annuluses, referenced 3a for the disk 3 and 5a for the flange 5, to enable them to be fastened to the

downstream end 6 of the downstream cone 7 of the high pressure compressor driven by the rotor 1.

The disk 3 includes an inside bore 8 passing the shaft 9 of a low pressure turbine, and the flange 5 presents an inside bore 10 that surrounds the clamping annulus 3a of the disk 3, and ventilation holes 11 through which a first flow C1 of cooling air taken from the bottom of the combustion chamber is delivered into the cavity 12 that separates the downstream face of the flange 5 from the upstream face of the disk 3. The flow C1 of cooling air flows radially outwards and penetrates into the recesses 4a that contain the roots of the blades 4 in order to cool said roots. The flow of air comes from the bottom of the combustion chamber, flows into a duct 13 disposed inside the enclosure 14 that separates the flange 5 from the bottom of the combustion chamber, and is drawn into rotation by injectors 15 in order to lower the temperature of the air delivered into the cavity 12.

A second flow C2 of cooling air taken from the bottom of the combustion chamber flows downstream inside the enclosure 16 that separates the downstream cone 7 in the high pressure compressor from the inner casing 17 of the combustion chamber 2. The flow C2 of air flows through a discharge labyrinth 18 and penetrates into the enclosure 14 from whence one portion C2a flows through the orifices 19 made in the upstream clamping annulus 5a of the flange 5, and then passes through the bore 10 of the flange 5 in order to cool the radially inner portion of the flange and joins flow C1 of air cooling the blades 4. Another portion C2b of the second flow C2 of air cools the upstream face of the flange 5, flows around the injectors 15 and is evacuated into the upstream venting cavity 20 of the turbine rotor 1.

Lastly, a third portion C2c of the second flow C2 of air serves to ventilate the upstream top face 21 of the flange 5 through a second labyrinth 22 that is situated

under the injectors 15. The third portion C2c penetrates into the enclosure 23 that is situated downstream of the second labyrinth 22, between the flange 5 and the injectors 15, and is evacuated into the upstream venting cavity of the turbine rotor 1 through a third labyrinth 24 that is situated above the injectors 15, or else it is mixed with the first flow C1 of air.

The second flow C2 of air serves to cool the downstream cone 7, the connection drum connecting the high pressure compressor to the high pressure turbine, and the flange 5. The second air flow that flows axially in an annular space delimited by the stationary walls secured to the chamber and the adjustable rotating walls secured to the rotor is heated by the power dissipated between the rotor and the stator.

In order to lower the temperature of the upstream flange to comply with its mechanical behavior specifications, it is therefore necessary to increase the flow C2 of air going through the discharge labyrinth 18 that is situated downstream from the high pressure compressor, and to expel it either into the circuit for cooling the blades or else into the exhaust gas stream that is upstream from the high pressure turbine wheel. Such an increase of flow rate results in an increase in the temperature of the air that cools the blades due to the discharge of air that has been heated in the blade cooling circuit, and results in a drop in performance of the turbine due to the discharge into the exhaust gas stream.

Moreover, the flow C2c of air that serves to cool the flange downstream from the second labyrinth 22, said labyrinth being situated under the injectors 15, cannot be easily controlled since it is subject to the variations that occur, while the engine is in operation and over the lifetime of said engine, in the clearances in the discharge labyrinth 18, in the second labyrinth

22, and in the third labyrinth 24, said third labyrinth being situated above the injectors 15.

In order to prevent large leaks from passing through the third labyrinth 24 that is situated above the injectors 15, said third labyrinth comprises three successive wipers that are formed on an angled portion 25 of the flange 5, said wipers cooperating with sealing elements 26 secured to an annular structure 27 inserted between the outside wall 28 of the duct 13 and the upstream portion 29 of the inside casing 27. This type of three-wiper labyrinth is of a considerable weight, and, because of centrifugal forces, it requires the flange 5 to be fastened onto the upstream face of the turbine disk 3 by means of a claw coupling 30.

The prior art is also described in FR 2 541 371 and FR 2 744 761. Both documents teach the presence of two labyrinths downstream from the main injectors, and the first flow of air crossing through the second flow of air via branch ducts passing through the circuit for the first flow of air.

The first object of the invention is to modify the sealing device upstream from the main injectors, in order to lighten the upstream flange.

A second object of the invention is to allow for a decrease in the venting flow rate upstream from the rotor, thereby achieving a saving in specific consumption.

A third object of the invention is to raise the pressure levels in the cooling air supply circuit of the turbine wheel, which is favorable for cooling the blades.

The invention achieves the first object by the fact that, downstream from the main injectors in the flow direction of the second flow of cooling air, the sealing device comprises at least three labyrinths that are radially spaced apart, being disposed between the flange and the annular structure.

Most advantageously, each of said three labyrinths comprises a single wiper.

Each of the labyrinths is thus light in structure, which makes it possible to omit the claw coupling.

The invention achieves the second and third objects by the fact that one of the annular cavities lying between two consecutive labyrinths out of said three labyrinths is fed by cooling air coming from the second circuit upstream from the under-injector labyrinth.

Advantageously, this third flow of air is drawn into rotation in the same direction as the rotation of the rotor by the secondary injectors.

Preferably, the secondary injectors are made in the form of sloping holes formed in the annular structure.

Other advantages and characteristics of the invention appear on reading the following description given by way of example and with reference to the accompanying drawings in which:

- Figure 1 is an axial half-section of a high pressure turbine rotor in a turbojet, showing the cooling air circuits and the different sealing labyrinths of the prior art; and

- Figure 2 is an axial half-section of a turbojet turbine rotor showing the disposition of the flange and the labyrinths of the invention, upstream from the main injectors.

The prior art shown in Figure 1 is described in the introduction and needs no further explanation.

Figure 2 shows a high pressure turbine rotor referenced 1 that is disposed downstream from a combustion chamber 2, which comprises a turbine disk 3 fitted with blades 4 on its periphery, and a flange 5 that is disposed upstream from the disk 3. The disk 3 and the flange 5 define between them a cavity 12 that is fed with cooling air via main injectors 15 and via holes 11 made in the flange 5 and opposite the main injectors 15. The main injectors 15 slope relative to the axis of

rotation of the turbine so as to direct the air they supply in the direction of rotation of the turbine rotor 1.

The main injectors 15 are fed with air taken from the bottom of the combustion chamber by means of an annular duct 13 which comprises a radially inner wall 13a and a radially outer wall 28.

A second labyrinth, not shown in Figure 2, is disposed under the main injectors, between the radially inner wall 13a and the flange 5. An annular structure 27 is inserted between the radially outer wall 28 of the duct 13 and the upstream portion 29 of the inner casing of the combustion chamber 2.

As can be seen in Figure 2, the invention provides for three radially spaced apart labyrinths 31, 32, and 33, replacing the third labyrinth 24 of the prior art, said three labyrinths lying between the cavity 23 that is situated upstream from the second labyrinth and the upstream venting cavity 20 in the turbine rotor 1 and above the main injectors 15. Each of the three labyrinths 31, 32, and 33 comprises a single wiper, and together they define two intermediate cavities 34 and 35 between the enclosure 23, into which the main injectors 15 and the upstream venting cavity 2 emerge.

Without leaving the ambit of the invention, the labyrinths 31, 32, and 33 could be replaced by other rotor/stator sealing systems, such as brush gaskets, and there could also be a combination of labyrinths and of brush gaskets.

Branch holes 36 made through the wall of the annular duct 13 serve to put the enclosure 14, which is under the combustion chamber and is disposed downstream from the second labyrinth that is situated under the main injectors, into communication with the enclosure 37 that is situated radially outer the annular duct 13. Bore holes 38 that slope relative to the axis of rotation of the turbine rotor 1 are made in the annular structure 27

between the enclosure 37 and the cavity 35 that is situated immediately upstream from the venting cavity 20. The bore holes 38 slope in the direction of rotation of the turbine rotor 1 in order to reduce the temperature of the cooling air of the radially outer wall of the flange 5.

Because the air penetrating into the cavity 35 through the bore holes 38 comes from upstream from the labyrinth under the injectors, pressure in the cavity 35 is increased and the amount of air escaping through the labyrinths 31 and 32 is decreased.

This leads to increased pressure in the cavities 23 and 12, which is favorable to cooling the blades 4.

The fact that the invention replaces one over-injector labyrinth 24 of the prior art, comprising three wipers, with three radially spaced apart labyrinths 31, 32 and 33, each having a single wiper, makes it possible to simplify the structure of the radially outer portion of the flange 5. This portion comes in the form of a web having a radially inner end bearing on the roots of the blades 4 and on the teeth of the disk. Such a disposition makes it possible to reduce the weight of the flange 5 and eliminates the claw coupling of the flange 5 onto the disk 3, which increases the life times of the flange 5 and of the disk 3.

The bore holes 38 are graded in order to reduce the amount of air escaping from the venting cavity 20, which makes it possible to reduce specific consumption by about 0.1%.

The bore holes 38 constitute a system of secondary injectors which make it possible, via the branch holes 36 to make use of most of the air in the under-chamber cavity to cool the top of the upstream flange. This flow of air meets the air that cools the blades, which is why it is commonly referred to as a "shunt" flow. Without leaving the ambit of the invention, the sloping bore holes 38 may be replaced with vaned injectors or with

sloping tubes, assembled in the wall of the annular structure 27.